# City of Bonner Springs Water Supply & Treatment Plant Project

## WIFIA Letter of Interest

## Appendix B: Water Supply Evaluation

FINAL

# CITY OF BONNER SPRINGS WATER SUPPLY AND TREATMENT PLANT STUDY

## Water Supply Evaluation

**B&V PROJECT NO. 404408**



**PREPARED FOR**

City of Bonner Springs, Kansas

14 MAY 2020

BLACK & VEATCH

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# 1.0 Introduction

Black & Veatch (B&V) was retained by the City of Bonner Springs (City) to evaluate their raw water supply system including water rights, physical well characteristics, well performance, raw water supply requirements, and raw water quality.

# 2.0 Well Evaluation

Since the 1950s, the City of Bonner Springs has relied on a series of groundwater wells that produce water from the Kansas River alluvial aquifer for their primary source of water supply. The wells, located east of the K-7 bridge as depicted on Figure 2-1, are drilled to depths of approximately 80 feet below ground surface (bgs) with capacities that generally range from 250 to 500 gallons per minute (gpm). Table 2-1 summarizes available information about the existing wells.

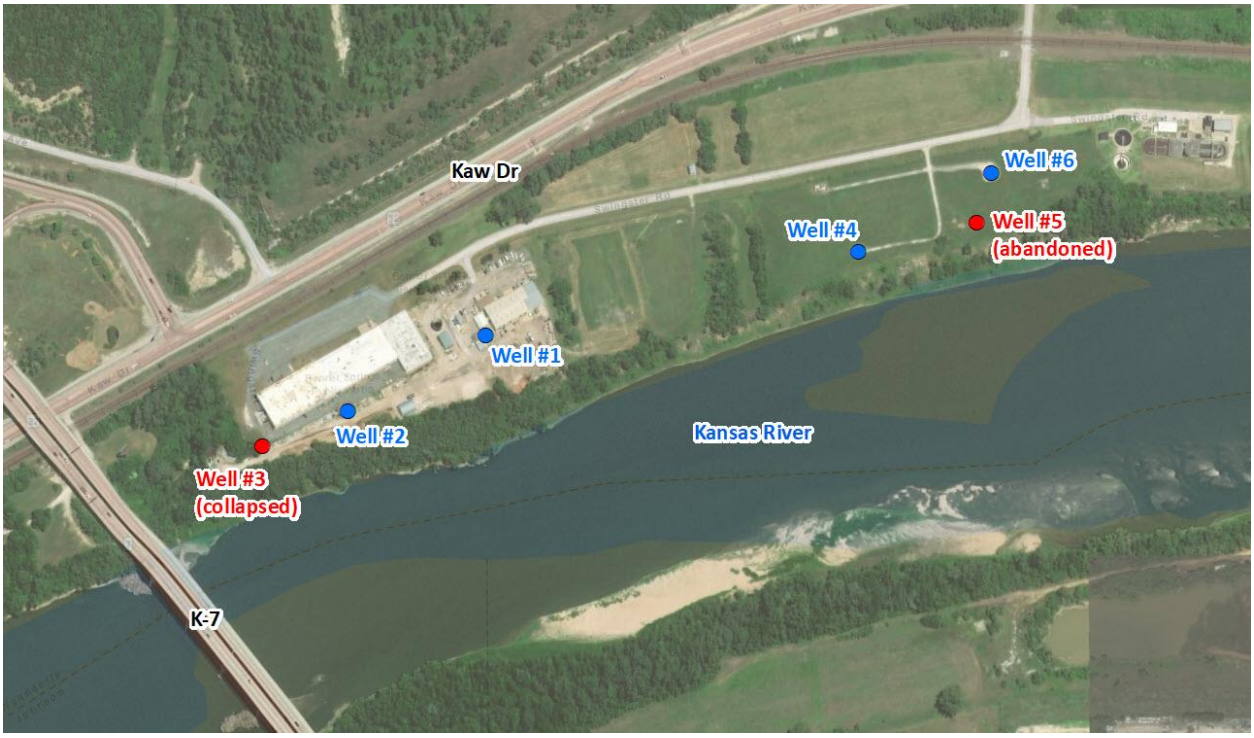


**Figure 2-1 Bonner Springs Wellfield (Section 28, Township 11S, Range 23E)**

**Table 2-1 Summary of Available Well Information**

| | WELL #1 | WELL #2 | WELL #3 | WELL #4 | WELL #6 |
|---|---|---|---|---|---|
| Age of well (years) | 68 | 46 | 52 | 38 | 5 |
| Reported static water level (feet below top of casing) | 59 | 58.6 | Collapsed in 2017 | 52.7 | 58 |
| Estimated saturated aquifer thickness at normal river level (feet) | 32 | 22 [a] | NA | 26 | 32 |
| Screen length (feet) | 19 | 20 | 19 | 11.5 | 10 |
| Reported static level above top of screen (feet) | 11 | 2 | 11 | 14.5 | 18.5 |
| Pump intake below top of screen (feet, approx.) * | 13.5 | 12.9 | NA | 5.5 | 11 |
| Reported pump type | Vert turbine | Submersible | | Submersible | Vert turbine |
| Current pump capacity from various sources (gpm) | 300, 350 | 150, 275, 350 | NA | 200 | 342, 500 |
| Original specific capacity (gpm/ft) | 50.9 | 58.4 @709 gpm | 82.5 @412 gpm | 27.32 @500 gpm | 101.1 @669 gpm |
| Other reported specific capacities (gpm/ft) | | 36.5 (5/00) | | | |
| Recent specific capacity (gpm/ft) | 89.3 @402 gpm (5/17) | 50.6 @369 gpm (3/16) | 65.7 (5/15) | 88.8 @357 gpm (4/16) | 96 @325 gpm (6/14/18) |
| Latest reported specific capacity (gpm/ft) | 75 @300 gpm (9/18) | 44 @150 gpm (9/18) | NA | NA | 76.9 @500 gpm (9/18 driller report) [b] |
| Reported well rehab/cleaning | 3/18 | 5/00; 3/18 | | 4/16 [c]; 3/18 | 3/18 |
| Reported pump installation/replacement | 2011 | 2000, 2010, 2013 | | | 2018 |
| Reported pump repair | 2017 | 2017 | 2017 | 2016b, 2017 | 8/18 |

**Notes:**
**a. Possibly recorded during low river flow.**
**b. 2/16 mineral incrustation and biofouling identified**
**c. 2019 Master Plan provides value of 100.4 @500 gpm**
***Individual wells do not appear to have water level indicators to monitor pumping water levels during normal operation.**

## 2.1 PHYSICAL CHARACTERISTICS OF THE WELLS

The Kansas Department of Health and Environment (KDHE) has guidelines for the classification of well water as groundwater under the direct influence of surface water (GWUI) which affects the treatment requirements related to Giardia cysts and viruses. KDHE's screening criteria state the following: "Sources most likely to be under the direct influence of surface water (GWUI) include infiltration lines, horizontal collector wells, and shallow wells with screen openings less than 50 ft.

(15 m) deep and located within 200 ft. (61 m) of surface water. Under the SWTR [Surface Water Treatment Rule], all GWUI must be treated like surface water".

Due to the limited saturated thickness of the aquifer (the significant depth to static groundwater levels), the criteria for 50 feet to the top of the screens appears to be met by the existing wells. For the 200-ft setback criteria, KDHE considers the limits of large flood events such as the 100-year flood shown on Figure 2-2, along with the water limits for smaller, more frequent flood events. KDHE confirmed that the existing wells, including Well #6 which was constructed in 2014, are classified as groundwater, and any new wells in the area with similar setback and depth characteristics to well #6 may also be classified as groundwater pending a more detailed KDHE assessment at that time. Replacement wells (Well #3) or wells constructed closer to the 100-year flood elevation are more likely to be classified as GWUI.

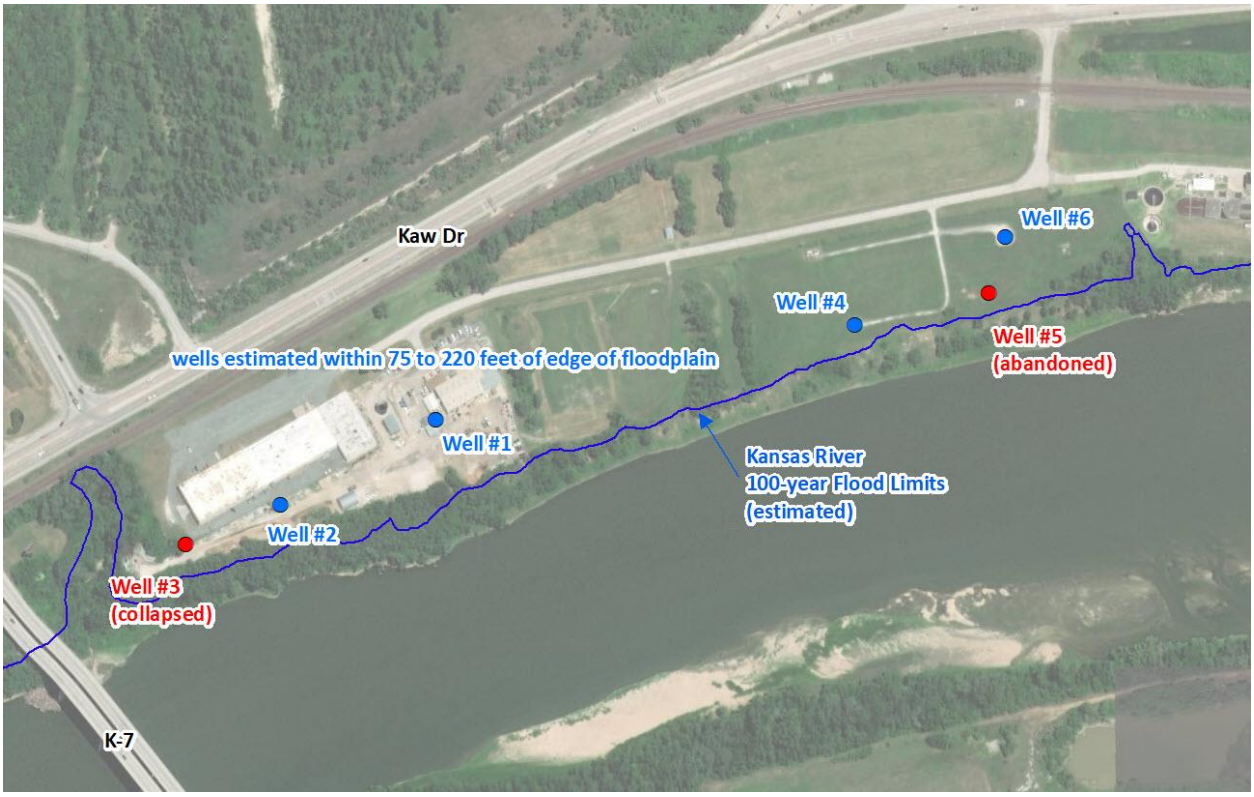


**Figure 2-2 Wells in Relation to Estimated 100-year Floodplain Limits**

## 2.2 WELL PERFORMANCE

B&V reviewed the available records provided by the City. Specific capacity records for each well as detailed in Table 2-1 are discussed below.

The original reported specific capacity for Well #1 was 51 gpm per foot of drawdown (gpm/ft); the date of this original test and the pumping rate is not known. The latest reported specific capacity was 75 gpm/ft in September 2018 at a pumping rate of 300 gpm. If the original test was performed in the early 1950s at a pumping rate close to 300 gpm, then an increase of 50 percent in the specific capacity of this well after 67 years is questionable.

Tests for Well #2 show an original specific capacity of 58.4 gpm/ft at a rate of 709 gpm, with no date provided. The latest specific capacity is reported to be 50.6 gpm/ft in March 2016 at a much lower rate of 369 gpm. If it is assumed that the original test was performed in 1973 and ignoring the large difference in the rates for each test, this well has lost about 13 percent of its original specific capacity. At an assumed current production rate of 300 gpm, this results in less than 1 foot of added decline in the pumping water level inside the well.

Similar to Well # 1, the original specific capacity for Well #4 is reported as 27.32 gpm/ft at 500 gpm, versus 88.8 gpm/ft at 357 gpm in April 2016, and this large increase is unclear. For a well in a sand and gravel aquifer, assuming the tests are performed consistently at the same pumping rate, the primary mechanism for the specific capacity to increase is through additional well development after original construction. This would be expected to occur early in the life of the well.

For Well #6, the driller's report for testing performed in September 2018 following acid treatment indicates a specific capacity of 76.9 gpm/ft at a pumping rate of 500 gpm. Table 2-2 of the 2019 Master Plan lists a specific capacity after treatment in September 2018 of 100.4 gpm/ft. This difference is unclear, so for purposes of this report it is assumed that the driller's report is correct. The original reported specific capacity for Well #6 (presumably in 2014) was 101.1 gpm/ft at a pumping rate of 669 gpm. Although the difference in the pumping rates during these tests is not ideal, these data points indicate Well #6 had lost 24 percent of its original specific capacity in approximately 4 years. At an assumed current production rate of 350 gpm, this results in only about 1.1 feet of added decline in the pumping water level inside the well.

Even though the Kansas River alluvium is typically very permeable, the saturated thickness limits the productivity of wells in this area. Static groundwater levels across the wellfield are primarily influenced by river levels. Under normal river conditions, the saturated thickness of the aquifer with the wells turned off appears to be about 32 feet or less. The older wells (Wells #1, #2, and #3) were constructed with screen lengths of approximately 20 feet; during normal river conditions, the static groundwater level is estimated to be up to 11 feet above the tops of these screens. The pump intakes are set near the bottoms of the wells within the screened sections, presumably to maximize the available drawdown and pumping capacity.

It is possible that the pumping water levels in the older wells are occasionally drawn near or below the tops of the screens. The exposure of the screens to oxygen typically promotes biofouling, which along with mineral incrustation and general deterioration of the well casing and screen, typically results in the need for more well maintenance over time. Wells #4 and #6 were constructed with shorter well screens which should reduce the potential to expose the screen to oxygen while pumping.

As Bonner Springs has seen with Well #3 and Well #5, and similar to other aging municipal wells along the Kansas River, several of the City's remaining older wells are approaching the end of their useful life which is typically assumed to be 50 years. However, based on the available maintenance records, several of the wells appear to respond favorably to treatment with various chemical and mechanical methods including acid, sodium hypochlorite, phosphate, and surging.

A more comprehensive assessment of individual well capacity could be performed if additional data is available or additional well testing is conducted.

# 3.0 Overview of Water Rights

Bonner Springs has the following Certificates of Appropriation for the Beneficial Use of Water through the Kansas Division of Water Resources (DWR):

- Water Right File No. WY-025: Priority Date 2/8/1955, Wells #1 & #2
- Water Right File No. 34,102: Priority Date 4/14/1980, Well #6
- Water Right File No. 34,103: Priority Date 4/14/1980, Well #4 – this right is tied to and further limited by File Nos. WY-025 & 34,102 (Wells #1, #2, #6)
- Water Right File No. 34,104: Priority Date 4/14/1980, Well #1 Overlap (this right is initiated only if the permitted quantity for File No. WY-025 for Well #1 is reached; this right is additive to WY-025)
- Water Right File No. 34,105: Priority Date 4/14/1980, Well #3 – this right is tied to and further limited by File Nos. WY-025; 34,102; 34,103; & 34,104 (Wells #1 including its overlap, #2, #4, #6)
- Water Right File No. 34,106: Priority Date 4/14/1980, Well #2 Overlap (this right is initiated only if the permitted quantity for File No. WY-025 for Well #2 is reached; this right is additive to WY-025) – this right is tied to and further limited by File Nos. WY-205; 34,102; 34,103; 34,104; & 34,105 (Wells #1 including its overlap, #2 including its overlap, #3, #4, #6)

The individual well water rights and the additional limitations applied to groups of wells are summarized in Table 2-1. Compared to typical water rights in Kansas, the interconnection between these water rights is somewhat complex. The City applied for the 34 series water rights in 1980 and were approved in 1983. Extensions were applied for over the years (5 to 10 year extensions) until the last extension ended in 2018 and Certificates of Appropriation were issued by DWR perfecting the 34 series of water rights. Water rights were established based on the maximum actual water production for each well and groups of wells leading up to 2018. The perfected quantities are much lower than what was applied for in 1980. Per discussions with DWR, the perfected water rights are final and the original rights may not be reinstated.

The City's rights roll up to the Certificate of Appropriation for File No. 34,106 which limits the total quantity of water for the 34 series rights plus the water right File No. WY-025 to a total quantity not to exceed 478.739 million gallons (1,469.2 acre-feet) of water per calendar year for municipal use. This total wellfield authorized quantity of 478.739 MG/yr is the maximum the wellfield can produce in a calendar year, equivalent to an average annual wellfield production of approximately 1.3116 MGD. It is important to note the maximum group water totals are less than the sum of the individual maximum pumping quantities for individual wells and rights. Consideration should be given to how wells are operated in order to pump the maximum total wellfield authorized quantity within the individual right restrictions. See Table 2-1 for more detail regarding the intermediate group and individual well limitations.

**Table 3-1 Summary of Annual Water Rights**

| WATER RIGHT | WELL | 1980 APPLICATION FOR MAXIMUM RATE (GPM) | 1955 AND 2018 PERFECTED MAXIMUM AUTHORIZED RATE (GPM)[1] | ORIGINAL 1980 APPLICATION FOR ANNUAL QUANTITY IN MG/YR | 1955 AND 2018 PERFECTED AUTHORIZED QUANTITY FOR INDIVIDUAL WELL IN MG/YR[2] | GROUP LIMITATIONS FOR WATER RIGHTS IN MG/YR (AND IN AVERAGE MGD) |
|---|---|---|---|---|---|---|
| WY-025 (1955) | #1 | NA | 345 | NA | 39.0 (used first, then shifts to "overlap" in 34,104 below) | |
| WY-025 (1955) | #2 | NA | 360 | NA | 39.0 (used first, then shifts to "overlap" in 34,106 below) | |
| 34,102 | #6 | 1000 | 760 | 263 | 166.273 | |
| 34,103 | #4 | 1000 | 240 | 263 | 75.932 | |
| | | | | | ***Further Group Limitation for Water Rights WY-025 + 34,102 + 34,103=*** | ***267.199 (0.732 MGD)[3]*** |
| 34,104 | #1 overlap | 450 | 345 | 131 | 131.000 | |
| 34,105 | #3 (collapsed) | 600 | 460 | 158 | 96.210 | |
| | | | | | ***Further Group Limitation for Water Rights WY-025 + 34,102 + 34,103 + 34,104 + 34,105=*** | ***415.949 (1.140 MGD)[4]*** |
| 34,106 | #2 overlap | 600 | 365 | 158 | 124.748 | |
| | | | | | ***Further Group Limitation for Water Rights WY-025 + 34,102 + 34,103 + 34,104 + 34,105 + 34,106=*** | ***478.739 (1.3116 MGD)[5]*** |

**Notes:**
**1. Sum of perfected maximum rates for the 34 series of rights of 2,170 gpm is 41% less than the sum of the rates in the 1980 applications.**
**2. Sum of perfected authorized quantities for the 34 series of rights for individual wells of 594.163 MG/yr is 39% less than the sum of the 1980 application quantities.**
**3. This group limit for Wells #1, #2, #4, and #6 is 17% less than the sum of the individual perfected quantities of 320.205 MG/yr, so it is necessary to track production from both the groups of wells and individual wells.**
**4. This group limit for Wells #1, #1 overlap, #2, #3, #4, and #6 is 24% less than the sum of the individual perfected quantities of 547.415 MG/yr, so it is necessary to track production from both the groups of wells and individual wells.**
**5. This group limit for Wells #1, #1 overlap, #2, #2 overlap, #3, #4, and #6 is 29% less than the sum of the individual perfected quantities of 672.163 MG/yr, so it is necessary to track production from both the groups of wells and individual wells.**

# 4.0 Future Raw Water Supply

## 4.1 WELL PRODUCTION

DWR provided reported water use from each of the City's wells since the 1980s. Figures 4-1 and 4-2 summarize the total wellfield production and individual well production, respectively. The downward trend over the past 10 years or so may be related to several factors such as increased appliance efficiency at residences, the wholesale water purchases from BPU, recent years being normal or wet, and the collapse of Well #3.

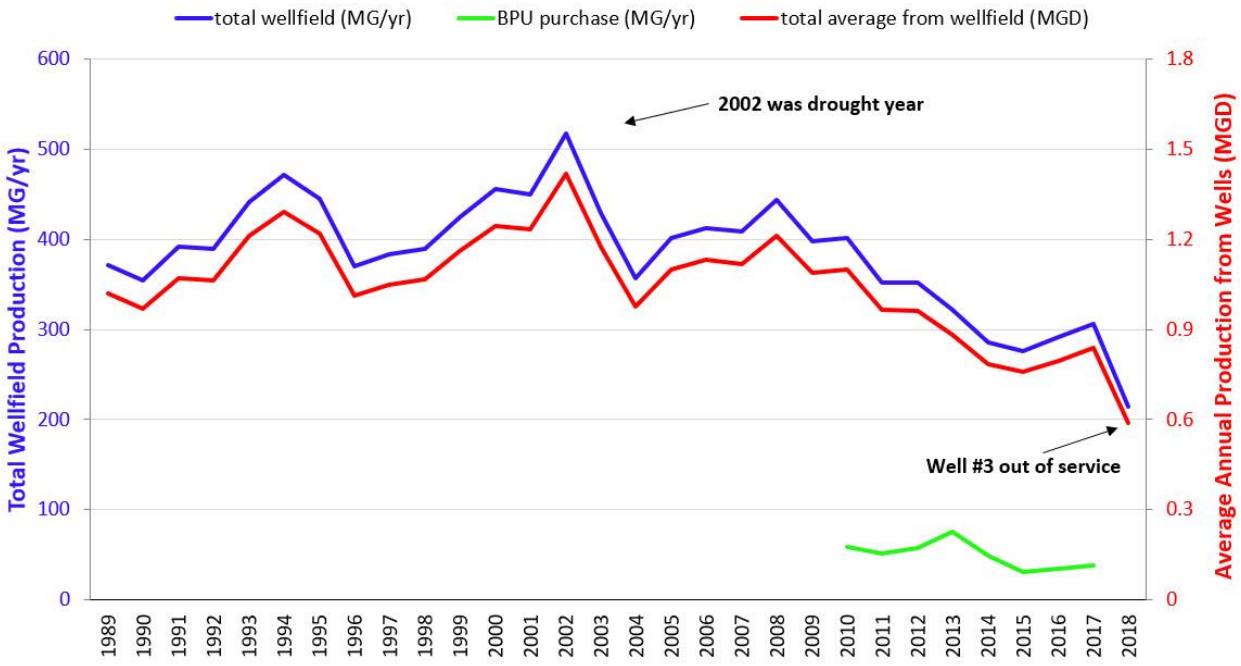


**Figure 4-1 Bonner Springs Total (and Average Annual) Wellfield Production since 1989**

(Source: DWR files)

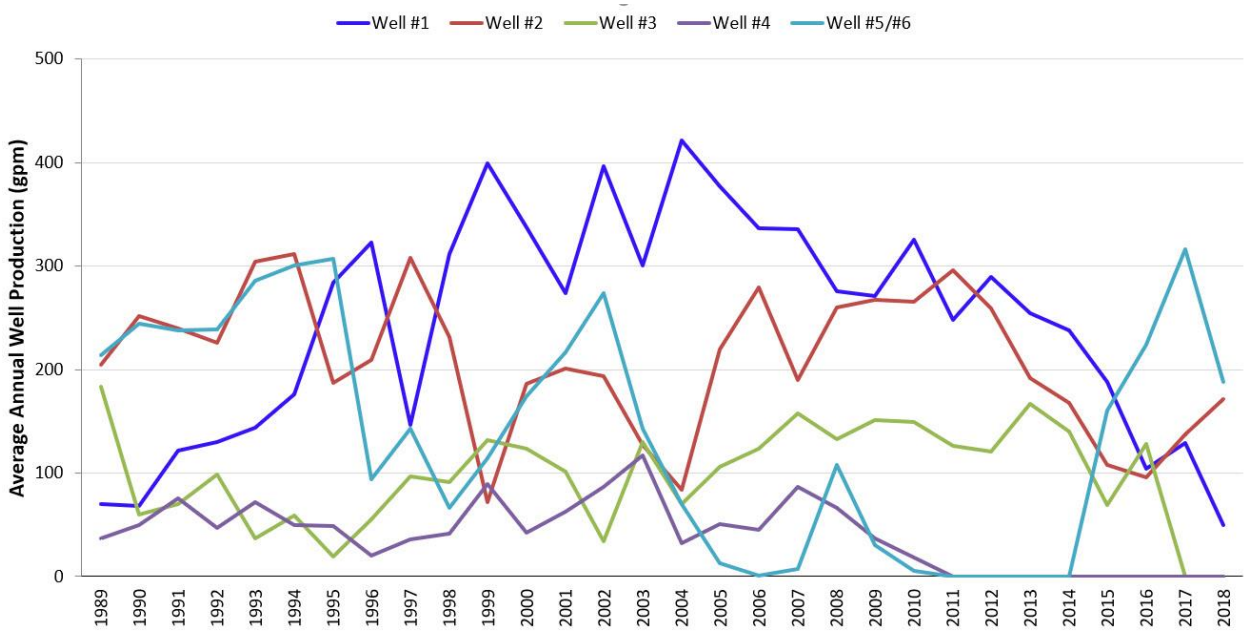


**Figure 4-2 Bonner Springs Average Individual Well Production since 1989**

(Source: DWR files)

Table 3-2 of the 2019 Master Plan provides water production from the wellfield and from BPU for 2010 to 2017. The "well water" production values in this table match the sum of the well water usage values given in DWR's records, so these values appear to be the inflow to the current treatment plant from the wellfield. These values would account for the water treatment plant waste streams (filter backwash water). The total amount of water purchased from BPU is also provided. On average, the total wellfield production has been 87 percent from the wellfield and 13 percent from BPU from 2010 – 2017, with total average water production ranging from 0.843 MGD to 1.261 MGD for these years.

## 4.2 FUTURE DEMAND PROJECTIONS

Table 3-5 of the Master Plan depicts projected water demands (including losses for the existing plant) for 2017 through 2060. Water projections were based on 115 gallons per capita day (with water loss). Table 5-1 depicts the projected raw water production needs for the City based on the 2019 Master Plan projected demands and accounting for the waste stream flows from a new precipitative softening water treatment plant. Water treatment plant waste streams were based on the use of reverse osmosis membranes for softening. Maximum day production needs are included in the table using the 2019 Master Plan assumption that maximum day/average day ratio is 1.5. Values are also given in MG/yr for average day and gpm for maximum day for comparison to the water rights in the following section.

**Table 4-1 Actual and Future Water Production Projections from All Sources of Supply**

| YEAR | ANNUAL AVERAGE DAY[1] MGD | FUTURE WTP WASTE STREAM MGD | TOTAL AVERAGE DAY WATER PRODUCTION MGD (MG/YR) | MAXIMUM DAY WATER PRODUCTION[2] MGD (GPM) |
|---|---|---|---|---|
| 2010 | 1.261 | NA | 1.261 (460.1) | 1.891 (1,313) |
| 2012 | 1.121 | NA | 1.121 (410.2) | 1.681 (1,167) |
| 2014 | 0.920 | NA | 0.920 (335.7) | 1.380 (958) |
| 2016 | 0.890 | NA | 0.890 (325.6) | 1.334 (926) |
| 2020 | 1.081 | 0.024 | 1.105 (404.44) | 1.658 (2,387) |
| 2025 | 1.149 | 0.026 | 1.175 (428.70) | 1.762 (2,537) |
| 2030 | 1.221 | 0.027 | 1.248 (455.57) | 1.872 (2,696) |
| 2040 | 1.381 | 0.031 | 1.412 (516.67) | 2.118 (3,048) |
| 2050 | 1.568 | 0.035 | 1.603 (585.03) | 2.404 (3,462) |
| 2060 | 1.784 | 0.040 | 1.824 (667.45) | 2.735 (3,939) |

[1] From 2019 Master Plan; it is unclear if
[2] Assuming a MD/AD factor of 1.5

In order to meet demands indicated in Table 4-1, new wells will be required. It is recommended that a more comprehensive assessment of individual well capacity be performed by reviewing additional data if available and performing groundwater modeling. Similar local wells have shown a production range of 250 to 300 gpm. Reference Table 4-2 for projected well construction assuming an average well production of 275 gpm. As discussed on section 2.2, a few of the wells are reaching the end of their useful life and will need to be replaced in the future.

**Table 4-2 Projection for New Well Construction**

| YEAR | MAXIMUM DAY WATER PRODUCTION[2] MGD (GPM) | | NUMBER OF REQUIRED WELLS (FIRM CAPACITY)[2] | SCHEDULE OF NEW WELL CONSTRUCTION[3] |
|---|---|---|---|---|
| 2020 | 1.658 | (1,151) | 6 | construct well # 3 replacement, add new well #7 |
| 2030 | 1.872 | (1,300) | 6 | replace wells # 1 & 2 due to age |
| 2040 | 2.118 | (1,470) | 7 | replace well # 4 due to age, add new well #8 |
| 2050 | 2.404 | (1,670) | 8 | Add new well #9 |
| 2060 | 2.735 | (1,900) | 8 | - |

[1] Approximate capacity of existing wells is 1,100 gpm based on 275 gpm per well
[2] Assumed average well production of 275 gpm per well. Additional groundwater modeling recommended to confirm well capacities.
[3] Well No's 1, 2 and 4 are 68, 46, and 38 years old respectively. Average life of a well is 50 years. As a result of the age of Wells # 1 & 2 recommend replacement of well in the near future with Well # 4 replaced within 20 years.

A total of 8 operating wells are required by 2060 to meet future maximum day water production projections. Well No's 1, 2, 4, and 5 are currently in operation (4 total) and Well No 3 has collapsed. Three (3) new wells and four (4) replacement wells for a total of seven (7) new wells are required by 2060.

## 4.3 WELLFIELD SUPPLY VERSUS WATER RIGHTS

DWR's records show a maximum annual wellfield production of 517.34 MG/yr (average of 1.417 MGD) in 2002, which was a drought year. This production was possible at that time because of the large water rights applied for in 1980 but could not occur today with the water rights that were perfected in 2018. In the past 10 years, the maximum average production from the wellfield plus purchased water was 460.1 MG/yr (Year 2010). If current water rights are maximized, 478.739 MG/yr or 1.3116 MGD can be pumped from the current wells. Based on the projections in the 2019 Master Plan, demand will approximately equal the available water rights in 2034. It is recommended that water purchases continue and increase with demands until a new well is constructed and additional new water rights are applied for.

Using the 2019 Master Plan assumption that maximum day/average day is 1.5, the estimated maximum day production in 2010 from all sources is 1.891 MGD. For the four wells currently in service, the total maximum authorized rate is 2.455 MGD, so the City could meet this rate for one day with their current rights without purchased water. Based on the projections, this rate will not be reached until sometime after 2040. Instead of being limited by the authorized maximum rates in the water rights, maximum day production for the four operational wells may be limited by the current pumping capacities of the wells considering the total dynamic head of the system including the drawdowns in the wells and/or available drawdown in the aquifer given the limited saturated thickness, particularly during low river flows.

## 4.4 SUMMARY AND RECOMMENDATIONS FOR THE WELLFIELD SUPPLY

A new well to replace Well #3 should be considered at this time for firm wellfield capacity to meet maximum day demands with one well as standby and to assist in managing the current water rights.

The rights of Well #3 can be transferred to this well (retaining the priority date of the right) provided the new well is installed within ½ mile of Well #3 and ¼ mile from the edge of the river within the Kansas River alluvial aquifer. The City can also explore applying for additional new rights for the new well that are independent of the existing rights; the amount applied for will be dependent on factors such as the projected demands for the planning horizon (e.g., 20 years), the sustainable yield of the new well at the location selected, and any continued reliance on water purchases. Until a new well and application for new rights are in place, the City will need to continue to rely on water purchases to avoid exceeding the current rights and to manage any pumping capacity limitations of the current wells, particularly during a drought year with increased demands. It is important to continue to track and record the quantities of groundwater produced by each well, along with the groups of wells, throughout the year to avoid exceeding one or more of the current water rights.

Over time, the need for additional new/replacement wells, as needed, will depend on factors such the following:

- As any of the older wells are taken out of service
- Hydraulic interference between adjacent wells and available drawdown during low river flows

- Any further changes to riverbed elevation or permeability - the Kansas River jetty located downstream of I-435 should maintain river levels past Bonner Springs under most river flow conditions
- Normal well deterioration over time
- Any water purchases in the future.

A typical conceptual opinion of probable construction cost for a well in this area would range from $450,000 to $550,000 excluding pipeline to the plant and additional contingency.

# 5.0 Raw Water Quality

Raw water quality data was taken from historical Bonner Springs information and data from nearby WaterOne and Olathe wells. Characteristics are summarized in Table 5-1. High calcium, magnesium, hardness, TDS, iron and manganese levels were noted. For comparison, purchased water from BPU has a hardness of approximately 290 mg/L compared to 440 mg/L in the raw water for Bonner Springs.

**Table 5-1 Raw Water Characteristics**

| CONSTITUENT | MCL (SMCL) | AVG |
|---|---|---|
| Calcium, mg/L as CaCO3 | --- | 349 |
| Magnesium, mg/L as CaCO3 | --- | 91 |
| Total Hardness, mg/L as CaCO3 | --- | 440 |
| Sodium, mg/L | --- | 68 |
| Alkalinity, mg/L as CaCO3 | --- | 220 |
| Chloride, mg/L | (250) | 108 |
| Sulfate, mg/L | (250) | 195 |
| Fluoride, mg/L | 4 (2) | 0.4 |
| Nitrate, mg/L | 10 | 0.4 |
| TDS, mg/L | (500) | 760 |
| Iron, mg/L | (0.3) | 0.20 |
| Manganese, mg/L | (0.05) | 2.0 |
| Silica, mg/L | --- | 21 |
| TOC, mg/L (Olathe) | --- | 1.79 |
| HAA5, µg/L (Finished Water) | 60 | 21 |
| THMs, µg/L (Finished Water) | 80 | 45 |
| Turbidity, NTU (Olathe) | --- | 33 |
| Iron, mg/L | (0.3) | 0.20 |

# 6.0 Conclusions and Recommendations

Physical Well Characteristics

- The wells are currently classified by KDHE as being a groundwater supply.
- If new wells are constructed a similar distance off-set from the river bank as Well Nos. 1, 2 & 3 (less than 200 ft.), KDHE may classify them as being under the influence of a surface water.
- If the City elects to construct a new WTP, the facility layout should accommodate the addition of a future chlorine contact basin to meet Primary Disinfection for a ground water supply under the influence of a surface water.

Well Performance

- The well cleanings appear to be effectively addressing biological fouling and mineral scaling.
- The development of long-term performance trends (specific capacity) would facilitate a more comprehensive assessment of the decline in well performance. To develop the trend, water temperature, static water depth in the alluvium and pumping rates would need to be documented at regular intervals.
- Well No. 1 is 68 years old and Well No. 2 is 46 years old. The expected useful life for wells is 50 years and, therefore, these wells have exceeded their useful life.
- Based on the age of Well Nos. 1 & 2, the City should include funds in the CIP for the replacement of these wells in the near term.
- Based on an average well production of 275 gpm and projected demands 8 total wells will be required by 2050. Below is the recommended schedule of new well construction and total wells required:
    - 2020: 6 total wells; Construct well # 3 replacement, add new well #7.
    - 2030: 6 total wells; Replace wells # 1 & 2 due to age.
    - 2040: 7 total wells; Replace well # 4 due to age, add new well #8.
    - 2050: 8 total wells; Add new well #9.
    - 2060: 8 total wells; No new wells anticipated.

Water Rights

- The current total water right is 478.739 MG/YR (Avg. Daily Rate = 1.31 mgd).

- Based on projected WTP waste stream rates and demand projections, additional water rights (and wells) would be required by 2034.

Water Quality

- High calcium, magnesium, hardness, TDS, iron and manganese levels were noted. For comparison, purchased water from BPU has a hardness of approximately 290 mg/L compared to 440 mg/L in the raw water for Bonner Springs.